Seattle Department of Planning and Development
— formerly the Department of Design, Construction and Land Use

CAM 419

client assistance memo

Commissioning for Nonresidential Mechanical and Lighting Systems

June 1999

OVERVIEW

The 1997 Seattle Energy Code contains completion and commissioning requirements for building mechanical systems in Section 1416 and for lighting controls in Section 1513.7. For mechanical systems, the completion requirements include record drawings, operating manuals and maintenance manuals, air and hydronic system balancing, and systems commissioning. For lighting, the requirements are limited to lighting controls. Reports are required to be filed with the owner.

In each case, the Code indicates that the construction documents shall require certain documentation or action. The owner receives commissioning documentation, not the building official. The building official only checks to be sure that the construction documents include the appropriate requirements. The building official does not review the commissioning documents themselves, nor witness any tests. However, for complex mechanical systems, a preliminary commissioning report is to be completed prior to the building official issuing a final certificate of occupancy.

For further information, see the attached list of resources.

BENEFITS OF COMMISSIONING

While Energy Codes specify that the installed equipment and systems must meet certain minimum requirements, the expected energy efficiency and energy savings have not always been achieved. The reasons vary: defective equipment, poor design, improperly installed systems, shoddy balancing, and lack of information for owners and maintenance staff to operate and maintain the equipment and systems correctly, etc. Typically, at least several of these factors contribute to the problems encountered on a project.

The benefits of completion and commissioning requirements in the Code include the benefits of the commissioning process that those who have done commissioning have come to understand well. (See Appendix C for overviews and case studies.) However, placing these requirements in the Code carries a new set of benefits. The requirements serve the interests of owners, contractors, utilities, architects and engineers.

The operations and maintenance divisions of most organizations have a difficult time convincing their capital projects counterparts of the life cycle cost-effectiveness of commissioning. The most persuasive approach is to demonstrate the cost-effectiveness. The Code requirements will create opportunities to demonstrate the value of commissioning to senior executives responsible for the O&M and capital budgets. Though many agree on the need for design intent narratives, it has proven difficult to convince the design professional to create these documents. Under the Code requirements, the owner will finally receive this vital information. More owners will reap the benefits of commissioning. Many of them will expand the scope of commissioning beyond that required by the Code.

Contractors who do quality work appreciate the leveling of the playing field brought about by the Code requirements for completion and commissioning. Contractors who rely on cutting corners to win low bid jobs will soon learn they cannot make a profit when they are held accountable for their shortcuts. They will need to change the way they do business. Reputable contractors become more cost competitive, and are awarded more contracts. This results in a higher overall standard of work, a benefit for all involved.

Electric utilities will be able to meet a greater portion of their load from their own resources. Reports cited in the appendices and proceedings from the seven national building commissioning conferences document the energy benefits of commissioning. However, other utilities also benefit from efficient use of their products. Natural gas usage declines for the same reasons electric consumption decreases. Water use is minimized when cooling towers are properly selected and adjusted, boiler blowdown is set effectively, and water purification systems backwash cycles are adjusted.

City of Seattle
Department of Planning & Development
Gregory J. Nickels, Mayor Diane Sugimura, Director

700 5th Avenue, Suite 2000
P.O. Box 34019
Seattle, WA 98124-4019
(206) 684-8600

Architects benefit from knowing that their consultants will have to consider operational issues more carefully. Those architects who already understand the benefits of commissioning will have an ally in making sure commissioning is implemented. Their projects will gain the prestige of working as intended.

Engineers benefit from knowing that there will be fewer spurious claims about the errors and omissions of their designs. Many design professionals express frustration at not being able to persuade their clients to include commissioning in the projects. When the design professional writes the narrative of system operation, they will benefit from the clarification of their own design intent. As more of their projects undergo commissioning, they will gain better feedback on how well their systems operate.

ADMINISTRATIVE ISSUES IN THE COMMISSIONING PROCESS

For the commissioning process to work well, there must be an understanding of the goals of commissioning and the roles and responsibilities of the various participants. The Building Commissioning Association (BCA), an organization devoted to building commissioning, has attempted to address these issues. Their webpage indicates that "The BCA was initially formed by building commissioning professionals of the Pacific Northwest to promote building commissioning in our region. We believe it is necessary to develop within our industry a common understanding of what constitutes effective building commissioning. We recognize the need to establish essential practices that maintain high professional standards, and fulfill building owners' expectations."

As defined by BCA, "The basic purpose of building commissioning is to provide documented confirmation that building systems function in compliance with criteria set forth in the Project Documents to satisfy the owner's operational needs. Commissioning of existing systems may require the development of new functional criteria in order to address the owner's current systems performance requirements."

The current consensus is that the commissioning process works best when there is a Commissioning Authority or Commissioning Agent or Commissioning Provider that works directly for the owner. The BCA has developed a set of principles for effective building commissioning for the Commissioning Authority to abide by that they call the "Essential Attributes of Building Commissioning." These principles are contained on the BCA website (www.bcxa.org/about/attributes.shtm) and are reprinted by permission in Appendix A. While the scope of commissioning addressed by the "Essential Attributes of Building Commissioning" is much more comprehensive than that required by the Seattle Energy Code, the general principles are still applicable. The BCA also has a peer review process to ensure that BCA members follow the principles. (For details of this process, see http://www.bcxa.org/about/peer_review.shtm). In addition, the National Environmental Balancing Bureau (NEBB) has a certification program for Commissioning Authorities.

Commissioning should NOT be a process that starts after the building is constructed and systems are installed. For the most successful commissioning, the Commissioning Authority should be involved as early in the process as possible, ideally prior to design. In "Issues in Commissioning Administration, Process, and Technique – A Case Study Collage" in the Conference Proceedings of the 7th National Conference on Building Commissioning, Mike Kaplan reports finding that "15% to 33% of the deficiencies owed their existence to the designers. (This includes inadequate specifications, incompatibility among specified pieces of equipment, equipment design issues, equipment-building automation system [BAS] interface design issues, and specified equipment that does not meet the design intent, as well as errors and omissions in the design.)"

The commissioning process needs to include all the important participants. The control contractor is another key player for the Commissioning Authority to work with. Kaplan states that "it is important that the control contractor participate in all commissioning meetings. In every project I've ever seen, controls have been involved in at least half of the commissioning issues. These can not be resolved without participation of the control contractor." However, this does not need to be an adversarial relationship. Kaplan continues that "the control contractor can be an invaluable source of help in understanding program code, navigating BAS, achieving remote access via modem, and so forth. My experience is that they are usually happy to assist with these things since they gain so much from the commissioning agent's testing and troubleshooting."

For a smooth process, the Commissioning Authority's responsibilities should be clearly spelled out. Failing to do this can create difficulties. Kaplan indicates that there can sometimes be a "gray area in interpreting and assigning responsibility for correction of problems. Unless the commissioning agent is seen as unbiased by all parties involved, it is unlikely that they will

accept his interpretation of problems." Recommendations for commissioning scope titled "Valuable Elements of Building Commissioning" are contained on the BCA website (www.bcxa.org/about/attributes.shtm) and are reprinted by permission in Appendix B.

Owners have an important role in the process. Owners should be aware that preparing a budget can be a challenge for a commissioning agent. Kaplan estimates that "at least 2/3 of the commissioning budget is highly dependent on factors beyond the commissioning agent's control. These factors include contractor performance, cooperation among the various commissioning team members, expanded construction schedules, design changes, expanded scope of testing, test repeats, and so forth…The discrepancy between expected and actual costs tends to be greatest when one or more members of the commissioning team are new or resistant to the commissioning process." Consequently, it is in the owner's best interest to set the tone and expectations for all participants from the start. Further, Kaplan emphasizes that "the owner must stay involved in the commissioning process no matter how long it takes to resolve all issues and deficiencies."

Finally, there is the question of the "price" of commissioning. Obviously, initial costs will vary depending on the extent to which the owner wants the commissioning agent involved in various aspects and phases of design, construction and completion. In terms of net costs, however, the title of an article by Carl Lawson in the January 1996 issue of the ASHRAE Journal answers this question succinctly: "The Price of Commissioning Equals Cost Savings." All owners and users want a building and systems that work. Commissioning helps ensure that they have this from the beginning of occupancy rather than after a period of 3-5 years of a piecemeal process trying to correct problems after designers and contractors are gone. It is much more efficient and much less costly for the original designers, manufacturers, and installers to resolve the issues working with a competent commissioning agent, than it is for building occupants to suffer through an unhealthy or uncomfortable work environment with the associated disruptions and loss-of-productivity.

COMMISSIONING RESOURCES

There are many resources available to provide guidance on commissioning. Portland Energy Conservation Inc. (PECI, 1400 SW Fifth Ave, Suite 700, Portland, OR 97201 phone: 503-248-4636; fax: 503-295-0820; e-mail: peci@peci.org; website: www.peci.org) has been the organizer for the National Conferences on Building Commissioning and is known as one of the leaders in the field. In addition to conference proceedings, the PECI website references many useful documents and provides links to ones that can be downloaded.

- A listing of Overviews and Case Studies is contained on the PECI website (www.peci.org/cx/overviews.html) and is reprinted by permission in Appendix C.
- A listing of Procedural Guidelines, Specifications, and Functional Tests is contained on the PECI website (www.peci.org/cx/guides.html) and is reprinted by permission in Appendix D.
- A summary of the Model Commissioning Plan and Guide Specifications is contained on the PECI website (www.peci.org/cx/mcpgs.html) and is reprinted by permission in Appendix E.
- A listing of websites with Commissioning Information and Documents is contained on the PECI website (www.peci.org/cx/weblinks.html) and is reprinted by permission in Appendix F.

The Oregon Office of Energy (503-378-4040) has a website that contains:

- An overview of commissioning, its benefits, and links to Oregon case studies and reports (www.energy.state.or.us/bus/comm/bldgcx.htm)
- A page titled "Commissioning Costs" that cites costs from commissioning for projects in Oregon (www.energy.state.or.us/bus/comm/commcost.htm)
- A page titled "Commissioning Savings" that cites saving from commissioning for projects in Oregon (www.energy.state.or.us/bus/comm/commsave.htm)

Other resources include issues from the past 10 years of the ASHRAE Journal and ASHRAE Transactions (peer-reviewed papers) which have published numerous articles and papers on various aspects of commissioning. (Available from ASHRAE, 1791 Tullie Circle NE, Atlanta, GA 30329 at 800-527-4723, www.ashrae.org.)

SEATTLE ENERGY CODE REQUIREMENTS FOR COMPLETION AND COMMISSIONING

The Seattle Energy Code requirements for completion and commissioning are summarized below on a section-by-section basis. Complying with these requirements may entail lengthy text which designers may wish to locate in the specifications. However, the drawings submitted with the permit application must, at a minimum, contain notes that the project will comply with the various Seattle Energy Code requirements in Sections 1416 and 1513.7.

Sample text for acceptable notes and recommendations for where to place these notes on the drawings submitted with the permit application are contained in Appendix G.

Record Drawings

Seattle Energy Code Section 1416.1 Drawings: This subsection requires record drawings be provided to the owner within 90 days after system acceptance.

> ***1416.1 Drawings:*** *Construction documents shall require that within 90 days after the date of system acceptance, record drawings of the actual installation be provided to the building owner. Record drawings shall include as a minimum the location and performance data on each piece of equipment, general configuration of duct and pipe distribution system, including sizes, and the terminal air and water design flow rates.*

Obtaining record drawings frustrates many owners. If completed at all, they arrive too late to be useful as a learning and diagnostic tool for the O&M staff, and are frequently nothing more than restamped bid documents. The Code requires timely delivery of these documents and defines minimum content.

The intent of the Code is to require drawing notes that call for the contractor to produce timely record drawings. Drawing notes should direct the contractor to update equipment schedules to reflect make, model, performance data, and equipment nomenclature to match field labeling of actual installed equipment (in contrast to specified or basis of design equipment). Drawings should show accurate locations of equipment which requires maintenance, labeled with equipment nomenclature to match field labeling. This is particularly important for control system components such as sensors, valves, dampers, relays and control boards and panels.

Operating Manuals and Maintenance Manual

Seattle Energy Code Section 1416.2 Manuals: This subsection requires that an operating manual and maintenance manual be provided to the owner.

> ***1416.2 Manuals:*** *Construction documents shall require an operating manual and maintenance manual be provided to the building owner. The manual shall be in accordance with industry accepted standards and shall include, at a minimum, the following:*
>
> *1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.*
>
> *2. Operation and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.*
>
> *3. Names and addresses of at least one service agency.*
>
> *4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field determined set points shall be permanently recorded on control drawings at control devices, or, for digital control systems, in programming comments.*
>
> *5. A complete narrative of how each system is intended to operate including suggested set points.*

(Also, note that the Mechanical Code Section 302.1 also requires that "Installers shall leave the manufacturer's installation and operating instructions attached to the equipment.")

Drawing notes should direct the creation of a project or systems manual. The manual contains a design intent narrative, an operating manual, a maintenance manual, contact information for local service organizations, and copies of approved submittal data and shop drawings.

The design intent narrative, created by the design engineer and updated by the installing contractor, describes how each system is intended to operate, including suggested setpoints. The design intent narrative is an introduction to the operating manual. Organization of both documents should be parallel, and should be presented by logical system groupings instead of CSI specification titles. A general information section of the operating manual should describe building description and function. It should also contain general operating parameters such as air and

water system setpoints, and ventilation rates. The technical information section of the operating manual describes normal operating procedures, system interfaces with other equipment and systems, seasonal start-up and shut down of equipment and systems, change of operating modes, special and emergency procedures, and troubleshooting.

The maintenance manual addresses equipment inventory and maintenance program needs. Information included should be: Descriptions of equipment; original purchase order number, date, vendor contact and warranty information; equipment function, capacity and performance data; recommended spare parts inventory; installation information; recommended maintenance schedules and procedures; and contact information for local manufacturer-authorized service organizations. Copies of approved equipment submittals should also be included.

Mechanical System Balancing

Seattle Energy Code Section 1416.3 System Balancing: This subsection requires that HVAC systems air and water flows be balanced to within 10% of design rates. The owner receives a written balance report.

1416.3 System Balancing

1416.3.1 General: *Construction documents shall require that all HVAC systems be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within 10% of design rates, except variable flow distribution systems need not be balanced upstream of the controlling device (for example, VAV box or control valve). Construction documents shall require a written balance report be provided to the owner.*

1416.3.2 Air System Balancing: *Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp, fan speed shall be adjusted to meet design flow conditions.*

1416.3.3 Hydronic System Balancing: *Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the ability to measure pressure across the pump, or test ports at each side of each pump.*

EXCEPTIONS:

1. Pumps with pump motors of 10 hp or less.

2. When throttling results in no greater than 5% of the nameplate horsepower draw above that required if the impeller were trimmed.

The Code requires balancing, "in accordance with generally accepted engineering standards." Drawings should reference current standards of organizations such as the Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or ASHRAE. These organizations provide instrumentation, procedural and reporting guidelines. The designer must call out the accuracy of balancing, within ten percent under this Code.

Mechanical System Commissioning

Seattle Energy Code Section 1416.4 Systems Commissioning: Requirements in this subsection are subdivided into "Simple Systems" and "Other Systems." For "simple systems" (packaged equipment as listed in Section 1421 of the Energy Code, as well as systems in warehouses and semiheated spaces), control systems are to be tested and a complete report of test procedures and results is to be filed with the owner. For "other systems," plans and specifications need to more specifically identify tests and criteria for acceptance. A preliminary commissioning report is to be prepared prior to issuance of the final certificate of occupancy for the building. A final, complete report of test procedures and results is to be filed with the owner.

1416.4 Systems Commissioning

1416.4.1 Simple Systems: *For simple systems, as defined in Section 1421, and for warehouses and semiheated spaces, HVAC control systems shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accord with approved plans and specifications. Sequences of operation shall be functionally tested to ensure they operate in accord with approved plans and specifications. A complete report of test procedures and results shall be prepared and filed with the owner. Drawing notes shall require commissioning in accordance with this paragraph.*

1416.4.2 Other Systems: *All other HVAC control systems, and other automatically controlled systems for which energy consumption, performance, or mode of operation are regulated by this code, shall be tested to ensure that control devices, equipment and systems are calibrated, adjusted and operate in accord with approved plans and specifications. Sequences of operation shall be functionally tested to ensure they operate in accord with approved plans and specifications.*

1416.4.2.1 Documentation: *Drawing notes shall require commissioning in accordance with this section. Drawing notes may refer to specifications for further commissioning requirements. Plans and specifications shall require tests mandated by this section be performed and the results recorded. Plans and specifications shall require preparation of preliminary and final reports of test procedures and results as described in 1416.4.2.2. Plans and specifications shall identify the following for each test:*

1. Equipment and systems to be tested, including the extent of sampling tests,
2. Functions to be tested (for example calibration, economizer control, etc.),
3. Conditions under which the test shall be performed (for example winter design conditions, full outside air, etc.),
4. Measurable criteria for acceptable performance.

1416.4.2.2 Commissioning Reports

1416.4.2.2.1 Preliminary Commissioning Report: *A preliminary commissioning report of test procedures and results shall be prepared. The preliminary report shall identify:*

1. Deficiencies found during testing required by this section which have not been corrected at the time of report preparation and the anticipated date of correction.
2. Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.
3. Climatic conditions required for performance of the deferred tests, and the anticipated date of each deferred test.

1416.4.2.2.2 Final Commissioning Report: *A complete report of test procedures and results shall be prepared and filed with the owner.*

1416.4.2.3 Acceptance: *Buildings or portions thereof, required by this code to comply with this section, shall not be issued a final certificate of occupancy until such time that the building official determines that the preliminary commissioning report required by this section has been completed.*

For "simple systems" such as a small air-cooled constant-volume packaged unit, typical functional tests include: calibration of sensors, proof of switch and actuator function, verification of balancing, refrigeration circuit operation, and sequence of control for scheduling and space condition control. These systems require special attention in recognition that they frequently get the least attention from designers and installers who may have the least familiarity with commissioning.

For "other systems" such as a VAV system with fan powered mixing boxes, functional tests typically performed include: calibration of sensors, proof of switch and actuator function, factory start-up of central equipment, verification of balancing, heating and cooling loop equipment and system functions, boiler, refrigeration circuit and heat exchanger operations, and sequence of control for scheduling and space condition control under various loads and in all seasons. The diversity of systems and sequences of operation for these systems make it impossible to provide a complete list in this document. See the list of references later in this document.

Lighting Control Commissioning

Seattle Energy Code Section 1513.7 Commissioning Requirements: This subsection requires that all lighting system controls be tested for functionality and sequence of operation. A complete report of test procedures and results is to be filed with the owner.

1513.7 Commissioning Requirements: *For lighting controls which include daylight or occupant sensing automatic controls, automatic shut-off controls, occupancy sensors, or automatic time switches, the lighting controls shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accord with approved plans and specifications. Sequences of operation shall be functionally tested to ensure they operate in accord with approved plans and specifications. A complete report of test procedures and results shall be prepared and filed with the owner. Drawing notes shall require commissioning in accordance with this paragraph.*

Lighting control commissioning has a significant impact on energy consumption. Other aspects of lighting and motors addressed by this chapter of the Code are less prone to functional deficiencies. Functions of the lighting control system to be functionally tested include: daylighting controls, occupant and daylight sensor calibration, adjustment and operation.

FOR FURTHER INFORMATION

For projects within the Seattle city limits, further information on the Seattle Energy Code requirements is available from the DPD Energy Code Technical Support Line at (206) 684-7846, available from 1:00-4:15 p.m., Monday-Friday. Or visit the Energy Code website at **www.seattle.gov/dpd/energy.**

APPENDIX A

Essential Attributes of Building Commissioning

BCA considers the following attributes to be so fundamental to effective building commissioning that all members agree in writing to adhere to them whenever they serve as a project's Commissioning Authority:

1. The Commissioning Authority (CA) is in charge of the commissioning process and makes the final recommendations to the owner regarding functional performance of the commissioned building systems.
2. The CA is an objective, independent advocate of the Owner. If the CA's firm has other project responsibilities, or is not under direct contract to the Owner, a conflict of interest exists. Wherever this occurs, the CA discloses, in writing, the nature of the conflict and the means by which the conflict shall be managed.
3. In addition to having good written and verbal communication skills, the CA has current engineering knowledge, and extensive and recent hands-on field experience regarding:

   a. Building systems commissioning,
   b. The physical principles of building systems performance and interaction,
   c. Building systems start-up, balancing, testing and troubleshooting,
   d. Operation and maintenance procedures, and
   e. The building design and construction process.
4. For each project, the commissioning purpose and scope are clearly defined in the CA contract.
5. The CA recommends the commissioning roles and scope for all members of the design and construction teams be clearly defined in:

   a. Each design consultant's contract,
   b. The construction manager's contract,
   c. General Conditions of the Specifications,
   d. Each division of the specifications covering work to be commissioned, and
   e. The specifications for each system and component for which the suppliers' support is required.
6. Each project is commissioned in accordance with a written commissioning plan that is updated as the project progresses. The commissioning plan:

   a. Identifies the systems to be commissioned,
   b. Defines the scope of the commissioning process,
   c. Defines commissioning roles and lines of communications for each member of the project team, and
   d. Estimates the commissioning schedule.
7. On new building commissioning projects, the CA reviews systems installation for commissioning related issues throughout the construction period.
8. All commissioning activities and findings are documented as they occur. These reports are distributed as they are generated, and included in the final report.
9. The functional testing program objectively verifies that the building systems perform interactively in accordance with the Project Documents. Written, repeatable test procedures, prepared specifically for each project, are used to functionally test components and systems in all modes of operating conditions specified for testing. These tests are documented to clearly describe the individual systematic test procedures, the expected systems response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion.
10. The commissioning authority provides constructive input for the resolution of system deficiencies.
11. Every commissioning project is documented with a commissioning report that includes:

    a. An evaluation of the operating condition of the systems at the time of functional test completion,
    b. Deficiencies that were discovered and the measures taken to correct them,
    c. Uncorrected operational deficiencies that were accepted by the owner,
    d. Functional test procedures and results,
    e. Reports that document all commissioning field activities as they progress, and
    f. A description and estimated schedule of required deferred testing.

Source: Building Commissioning Association website at *http://www.bcxa.org/about/attributes.shtm*
Page last modified: 28 June 2004

APPENDIX B

Valuable Elements of Building Commissioning

Building commissioning is of greatest value to the owner when it provides, throughout the many phases of design and construction, a means of continuously communicating their building systems criteria and rigorously verifying compliance with these. In order to accomplish this BCA recommends that the building commissioning scope include the following elements.

1. Prior to design, assist the Owner in evaluating the facility's requirements regarding such issues as energy conservation, indoor environment, staff training, and operation and maintenance.
2. Review all phases of design and construction documents for:

   a. Compliance with design criteria,
   b. Commissioning requirements,
   c. Bidding issues,
   d. Construction coordination and installation concerns,
   e. Performance aspects, and
   f. Facilitation of operations and maintenance, including training and documentation.
3. Review the equipment submittals for compliance with commissioning issues.
4. Verify or manage the scheduling and procedures used for system start-up.
5. Verify that the training for the owner's operating staff is conducted in accordance with the project documents.
6. Verify that the operations & maintenance manuals comply with the contract documents.
7. Prior to expiration of the construction contract warranty, assist the owner in assessing systems' performance and addressing related issues.

Source: Building Commissioning Association website at *http://www.bcxa.org/about/attributes.shtm*
Page last modified: 28 June 2004

APPENDIX C

Commissioning Resources

Overviews and Case Studies

Building Commissioning: The Key to Quality Assurance. USDOE Rebuild America / PECI, 1998. Commissioning retrofits and existing buildings: overview, process and case studies. 68 pp. (Available at the Rebuild America website at www.rebuild.org/solutioncenter/newconstruction.asp.)

Commissioning For Better Buildings in Oregon. Oregon Office of Energy / PECI, 1997. New construction overview, benefits, process and case studies. 44 pp. (Available at the OOE website at www.energy.state.or.us/bus/comm/bldgcx.htm.)

What Commissioning Can Do For Your Building? PECI, 1997. This colorful, informative brochure is designed to help commissioning providers sell their services to owners and is derived from a database of 175 case studies of commissioning of new construction, equipment replacements and upgrades in existing facilities, and "tune-up" work for existing facilities. This document presents the costs and benefits demonstrated by these case studies. 12 pp. 503-248-4636.

Commissioning Four New Science Laboratory Buildings (U. of WA). Bonneville Power Admin. / Phoebe Caner, 1997. Commissioning case studies with detailed "lessons learned" information in all sections. ~70 pp. 503-230-7334.

Commissioning the Physics/Astronomy Building Control System (U. of WA). Bonneville Power / Phoebe Caner, 1996. Commissioning case study and report with lessons learned. ~110 pp. 503-230-7334.

Source: Portland Energy Conservation, Inc. (PECI) website at *http://www.peci.org/cx/overviews.html*
Page last modified: 31 Jan 2003

APPENDIX D

PECI Commissioning Resources
Procedural Guidelines, Specifications, and Functional Tests

Back to Commissioning Resources

Notes: 💾 denotes that the documents are available on **electronic disk. D** = for design phase. **C** = for construction phase. **ALL CAPS** denotes document is more comprehensive than lower case. Documents are listed **newest to oldest.** Last updated: April 27, 1998

Document and Source	Guidelines	Guide Specs	Sample Tests
Model Commissioning Plan and Guide Commissioning Specifications, USDOE/PECI, 1997. NTIS: # DE 97004564 800-553-6847. Available at PECI's Web site.	Some D, c 💾	YES D, C 💾	YES 💾
Building Commissioning Guide, U.S. General Services Administration and USDOE, 1995, revised in 1997. Version 1 by Enviro-Management & Research, Inc. Available at USDOE/FEMP Web site.	Yes D, C 💾	No	No
The HVAC Commissioning Process, ASHRAE Guideline 1-1996, 1996. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes d, C	Some d, c	No
The Building Commissioning Handbook, The Association of Higher Education Facilities Officers (APPA), written by John Heinz and Rick Casault, 1996. APPA, 1643 Prince Street, Alexandria, VA 22314.	YES d, C	YES C	No
Engineering and Design Systems Commissioning Procedures, U.S. Army Corps of Engineers, 1995 (ER 1110-345-723). Department of the Army, U.S. Army Corps of Engineers, Washington, DC 20314-1000.	Some d, c	Some d, c	No
Commissioning Specifications, C-2000 Program, Canada, 1995. C-2000 Program, Energy Mines & Resources, Energy Efficiency Division, 7th Floor, 580 Booth St., Ottawa, Ontario, Canada K1A 0E4.	No	YES C 💾	No
Model Construction Document Specifications and A/E Services Contract Clauses. Bonneville Power Administration/John Heinz, U. of WA, 1995. 503-230-7334. Available at the Univ. of Washington Web site.	No	YES C 💾	Some
Commissioning Guidelines, Instructions for Architects and Engineers, State of Washington, 1995. Dept. of General Administration, Div. of Engineering & Architectural Services, (360) 902-7272.	Yes d, c	No	No

APPENDIX D, cont.

Commissioning of HVAC Systems, seminar/workshop training materials, Univ. of Wisconsin, Madison, 1994. 800-462-0876 or 608-262-2061	Some C	Some C	Some
Laboratory HVAC Systems: Design, Validation and Commissioning, ASHRAE collection of 11 papers, 1994. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes C	No	No
Commissioning Smoke Management Systems, ASHRAE Guideline 5-1994. ASHRAE Publications Dept., 1791 Tullie Circle, NE, Atlanta, GA 30329.	Yes d, c	No	No
Standard HVAC Control Systems Commissioning and Quality Verification User Guide, U.S. Army Const. Engineering Research Laboratories, 1994. Facilities Engineering Applications Program, U.S. Army Engineering and Housing Support Center, Ft. Belvoir, VA 22060-5516. FEAP-UG-GE-94/20.	No	No	Yes
Contractor Quality Control and Commissioning Program—Guidelines and Specification, Montgomery Co. Gov., St of Maryland, 1993. 301-217-6071.	Yes c 🖫	YES C 🖫	Some 🖫
Procedural Standards for Building Systems Commissioning, National Environmental Balancing Bureau (NEBB), 1993. NEBB, 1385 Piccard Drive, Rockville, MD 20850. 301-977-3698	Yes d, c	Some d, c	Some
HVAC Systems Commissioning Manual, Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 1993. SMACNA, 4201 Lafayette Center Dr., Chantilly, VA 22021.	Yes c	Some c	Some
Guide Specification for Military Construction—Commissioning of HVAC Systems, Department of the Army, U.S. Army Corps of Engineers, January, 1993. Washington, DC 20314-1000	No	Some c 🖫	YES 🖫
Commissioning Guide, Public Works Canada, Western Region, 1993. 403-497-3770.	Some d, c	Yes d, C	No
Building Commissioning Guidelines, Bonneville Power Administration/PECI, 1992. 503-230-7334.	YES d, C	Some c	Some
HVAC Functional Inspection and Testing Guide, U.S. Dept. of Commerce and the General Services Administration, 1992. NTIS: 800-553-6847.	No	No	YES
Thermal Energy Storage (TES) Commissioning Guidelines, California Institute for Energy Efficiency, San Diego State University, 1991. San Diego State University, Energy Engineering Institute, San Diego, CA 92182.	Yes C	No	Yes
AABC Master Specification, Associated Air Balance Council (Primarily for how the TAB fits into the commissioning process) AABC National Headquarters, 202-737-0202.	No	Yes d, C 🖫	No

APPENDIX E

PECI Commissioning Resources

Model Commissioning Plan and Guide Specifications

A complete toolkit of materials to incorporate building commissioning into your project!

Version 2.05 (February 1998)

Back to Commissioning Resources

On this page: Benefits | Overview | Audience | **Download** | Credits

Benefits

- Obtain an expert commissioning provider through the comprehensive commissioning services solicitation.
- Minimize system deficiencies by using the design phase commissioning requirements.
- Experience successful QA during construction by incorporating the detailed enforceable specifications.
- Enjoy a smooth building turnover by using the systematic commissioning procedures.
- Start TODAY using the fully editable electronic document format.

Overview

TOP

The ***Model Commissioning Plan and Guide Specifications*** details the commissioning process for new equipment during both the design and construction phases for larger projects. Going beyond commissioning guidelines, the document provides boilerplate language, content, format and forms for specifying and executing commissioning. The document generally builds upon *The HVAC Commissioning Process*, ASHRAE Guideline 1, 1996, with significant additional detail, clarification and interpretation added. The document contains four parts, totaling over 500 pages:

Part I. Commissioning Requirements–Design Phase
Commissioning requirements of the design team, including a full solicitation for commissioning services.

Part II. Model Commissioning Plan–Design Phase
Detailed commissioning boilerplate plan for commissioning during design, including design intent and basis of design format for 15 system types.

Part III. Commissioning Guide Specifications
Comprehensive guide specifications by specification section, covering protocols, procedures, and responsibilities of all parties. Includes complete specification language for Divisions 1, 15, 16 and 17. This part includes testing requirements for 15 system types. Also included are detailed prefunctional checklists for 20 types of equipment and example functional test procedures for 30 system types.

Part IV. Model Commissioning Plan–Construction Phase
Modular boilerplate commissioning plan with 30 representative forms to facilitate the commissioning process.

APPENDIX E, cont.

Audience

Owners
Provides owners with a commissioning process they can direct their design and construction teams to incorporate. The document also provides a full commissioning services solicitation RFP.

A/E
Architects and engineers can use the document to guide them through the commissioning process during both design and construction, including the development of commissioning specifications. Boilerplate language has been provided electronically to ease the customizing process.

Commissioning Providers
Commissioning providers can use the design and construction phase boilerplate commissioning plans for developing site-specific plans. The guide commissioning specifications will assist the commissioning provider in developing site-specific specifications. Construction-phase commissioning forms have been provided, as well as prefunctional and example functional tests.

Project Managers
Building construction and project managers can use the document to learn how the process is structured, the typical documentation required and the management protocols that may be used.

All EXE files are **self-extracting archives** that contain **Word 6.0** documents and/or **Excel 5.0** worksheets created under Windows. Other files are as noted.

To download a file, click its file name.

Depending on your browser and its associated "helper" applications, you may need to use an alternate method to download. Right-click the link then select **Save Link As** (Netscape) or **Save Target As** (Internet Explorer).

readme.txt	**Instructions for extracting downloaded files** 5 Kb, ASCII text file
spec&pln.exe	**Model Commissioning Plan and Guide Specification** Version 2.05, February 1998 695 Kb
cxtests.exe	**Sample functional tests and checklists** Version 2.05, February 1998 800 Kb
history.doc	**Revision history** 21 Kb, Word 6.0 document
alldocs.exe	**All files in one compressed archive** 1428 Kb

Printed copy:
Version 2.04 of this document is available printed and bound (without any section dividers) from the National Technical Information Service (NTIS). Call NTIS at 1-800-553-6847 and request document ID# DE97004564.

APPENDIX E, cont.

Credits

Versions 1.0 through 2.04 Sponsored by:
US Department of Energy
Seattle Regional Support Office
800 5th Ave., Suite 3950
Seattle, WA 98104

Version 2.05 Modifications Sponsored by:
Oregon Office of Energy
625 Marion Street NE
Salem, OR 97310
and
Portland Energy Conservation, Inc.

Prepared By:

Portland Energy Conservation, Inc. (PECI)
921 SW Washington, Suite 312
Portland, OR 97205
TEL: 503-248-4636
FAX: 503-295-0820
EMAIL: peci@peci.org

February 1998

Version 2.04 was distributed by PECI in 1997 and by USDOE in 1998, with USDOE referenced in the footer of each file. Since that version, changes and additions have been made by PECI without review by USDOE. Subsequently in Version 2.05 the reference to USDOE has been removed from the footers. Individual files may have been updated without changing the overall version number. An up-to-date history of changes is found in the file history.doc.

Version 2.04 is available on the USDOE web site at www.eren.doe.gov/femp/techassist/bldgcomgd.html.

APPENDIX F

Commissioning Resources

Websites with Commissioning Information and Documents

Building Commissioning Association
www.bcxa.org
Professional association that promotes building commissioning practices that maintain high professional standards, and fulfill building owners' expectations. Several documents available.

Commissioning Specialists Association of Great Britain
www.csa.org.uk/
Information on the association's purpose and services

Florida Design Initiative
http://sustainable.state.fl.us/fdi/edesign/resource/totalbcx
Ongoing articles & forum

National Environmental Balancing Bureau
www.nebb.org/bsc-man.htm
Certification program and manuals

Oak Ridge National Laboratory: Building Technology Center
www.ornl.gov/~webworks/cppr/y2001/rpt/101847.pdf
A Practical Guide for Commissioning Existing Buildings by PECI and ORNL

Oregon Office of Energy
www.energy.state.or.us/bus/comm/bldgcx.htm
Benefits of Commissioning, case study, tool kit of new and existing commissioning application materials and the full text of *Commissioning for Better Buildings in Oregon*

Texas A&M Energy Systems Lab
www-esl.tamu.edu
Retro-commissioning process and software, for sale

University of Washington
depts.washington.edu/fsesweb/fdi/fdi.html
University commissioning guide specifications

APPENDIX G

Sample Text on Seattle Energy Code Completion and Commissioning Requirements to Include on Drawings Submitted with Permit Applications

Complying with the Seattle Energy Code completion and commissioning requirements in Sections 1416 and 1513.7 may entail lengthy text which designers may wish to locate in the specifications. However, the drawings submitted with the permit application must, at a minimum, contain notes indicating that the project will comply with the various Seattle Energy Code requirements in Sections 1416 and 1513.7. The following sample notes are considered adequate to comply with the completion and commissioning requirement for mechanical systems and for lighting controls.

- If the applications is combined building and mechanical, it is recommended that the following notes with the mechanical commissioning requirements be placed on sheet M-1 or the first available M sheet.
- If the application is mechanical permit only, it is recommended that the notes with the mechanical commissioning requirements be placed on the cover sheet or sheet M-1.
- If the application is for building permit (with or without mechanical), it is recommended that the notes with the lighting control commissioning requirements be placed on sheet E-1 or, if no E sheet, then on the reflected ceiling plan of the A sheets.
- If the application is for electrical permit, it is recommended that the notes with the lighting control commissioning requirements be placed on the first lighting sheet.

Mechanical

Completion and Commissioning for Mechanical Systems

Record drawings of the actual installation shall be provided to the building owner within 90 days of the date of system acceptance per Seattle Energy Code (SEC) Section 1416.1.

An operating manual and maintenance manual shall be provided to the building owner per SEC Section 1416.2.

All HVAC systems shall be balanced and a written balance report shall be provided to the owner per SEC Section 1416.3.

For warehouses, semiheated spaces, and simple systems (as defined in SEC Section 1421): HVAC controls systems shall be tested, calibrated and adjusted, sequences of operation shall be tested to ensure that they operate in accord with specifications and approved plans, and a complete report of test procedures and results shall be filed with the owner per SEC Section 1416.4.1.

For all other systems: HVAC control systems shall be tested, calibrated and adjusted, sequences of operation shall be tested to ensure that they operate in accord with specifications and approved plans per SEC Section 1416.4.2; necessary tests shall be identified per SEC Section 1416.4.2.1; a preliminary commissioning report of test procedures and results shall be prepared prior to issuance of a final certificate of occupancy per SEC Section 1416.4.2.2.1 and 1416.4.2.3; and a complete final commissioning report of test procedures and results shall be filed with the owner per SEC Section 1416.4.2.2.2.

Lighting

Commissioning for Lighting Controls

For lighting controls that include daylight or occupant sensing automatic controls, automatic shut-off controls, occupancy sensors, or automatic time switches: the lighting controls shall be tested, calibrated and adjusted, sequences of operation shall be tested to ensure that they operate in accord with specifications and approved plans, and a complete report of test procedures and results shall be filed with the owner in accordance with Seattle Energy Code Section 1513.7.